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B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2013.

Third Semester

Mechanical Engineering

ME 2204/CE 3213/ME 34/CE 1208/10122 ME 305/080180007 — FLUID MECHANICS AND MACHINERY

(Common to Aeronautical Engineering, Automobile Engineering, Production Engineering, Mechatronics Engineering, Mechanical and Automation Engineering and Fourth Semester Manufacturing Engineering, Industrial Engineering and Industrial Engineering and Management)

(Regulation 2008/2010)

(Common to PTCE 3213/PTME 2204 – Fluid Mechanics and Machinery for B.E. (Part-Time) Third Semester – Manufacturing Engineering Regulation 2009)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Define relative or specific viscosity.

2. What do you understand by impulse momentum equation?

3. Mention the general characteristics of laminar flow.

4. What do you mean by flow through parallel pipes?

5. Give the dimensions of the following physical quantities: surface tension and dynamic viscosity.

6. State Froude's model law.

7. Define hydraulic efficiency and axial thrust of a roto-dynamic hydraulic machine.

8. Distinguish between reaction turbine and impulse turbine.

9. What is negative slip in a reciprocating pump? What are the causes for it?

10. What are the advantages of air vessel?

PART B — ($5 \times 16 = 80$ marks)

11. (a) (i) A liquid is compressed in a cylinder having a volume of 0.012 m^3 at a pressure of 690 N/cm^2. What should be the new pressure in order to make its volume 0.0119 m^3? Assume bulk modulus of elasticity (K) for the liquid = 6.9×10^4 N/cm^2. (8)

(ii) A 15 cm diameter vertical cylinder rotates concentrically inside another cylinder of diameter 15.10 cm. Both cylinders are 25 cm high. The space between the cylinders is filled with a liquid whose viscosity is unknown. If a torque of 12.0 Nm is required to rotate the inner cylinder at 100 r.p.m., determine the viscosity of the fluid. (8)

Or

(b) (i) State Bernoulli's theorem and assumptions for steady flow of an incompressible fluid. (4)

(ii) The water is flowing through a taper pipe of length 100 m having diameters 600 mm at the upper end and 300 mm at the lower end, at the rate of 50 litres/s. The pipe has a slope of 1 in 30. Find the pressure at the lower end if the pressure at the higher level is 19.62 N/cm^2. (12)

12. (a) For a flow of viscous fluid flowing through a circular pipe under laminar flow conditions show that the velocity distribution is a parabola. And also show that the average velocity is half of the maximum velocity. (16)

Or

(b) A horizontal pipe line 40 m long is connected to a water tank at one end and discharges freely into the atmosphere at the other end. For the first 25 m of its length from the tank, the pipe is 150 mm diameter and its diameter is suddenly enlarged to 300 mm. The height of water level in the tank is 8 m above the centre of the pipe. Considering all losses of head which occur, determine the rate of flow. Take $f = 0.01$ for both sections of the pipe. (16)

13. (a) State Buckingham's π-theorem. The discharge of a centrifugal pump (Q) is dependent on N (speed of pump), d (diameter of impeller), g (acceleration due to gravity), H (monometric head developed by pump) and ρ and μ (density and dynamic viscosity of the fluid). Using the dimensional analysis and Buckingham's π-theorem, prove that it is given by $Q = Nd^3 f\left(\frac{gH}{N^2 d^2}, \frac{\mu}{Nd^2 \rho}\right)$. (16)

Or

(b) (i) What are the similarities between model and prototype. Mention the applications of model testing. (4)

(ii) A spillway model is to be built to a geometrically similar scale of $\frac{1}{50}$ across a flume of 600 mm width. The prototype is 15 m high and maximum head on it is expected to be 1.5 m.

(1) What height of model and what head on the model should be used?

(2) If the flow over the model at a particular head is 12 litres per second, what flow per metre length of the prototype is expected?

(3) If the negative pressure in the model is 200 mm, what is the negative pressure in prototype? Is it practicable? (12)

14. (a) A Francis turbine with an overall efficiency of 75% is required to produce 148.25 kW power. It is working under a head of 7.62 m. The peripheral velocity = $0.26\sqrt{2gH}$ and the radial velocity of flow at inlet is $0.96\sqrt{2gH}$. The wheel runs at 150 r.p.m. and the hydraulic losses in the turbine are 22 % of the available energy. Assuming radial discharge, determine :

(i) The guide blade angle

(ii) The wheel vane angle at inlet

(iii) Diameter of the wheel at inlet, and

(iv) Width of the wheel at inlet. (16)

Or

(b) The internal and external diameter of an impeller of a centrifugal pump which is running at 1000 r.p.m, are 200 mm and 400 mm respectively. The discharge through pump is 0.04 m^3/s and velocity of flow is constant and equal to 2.0 m/s. The diameters of the suction and delivery pipes are 150 mm and 100 mm respectively and suction and delivery heads are 6 m (abs.) and 30 m (abs.) of water respectively. If the outlet vane angle is 45° and power required to drive the pump is 16.186 kW, determine :

(i) Vane angle of the impeller at inlet,

(ii) The overall efficiency of the pump, and

(iii) Manometric efficiency of the pump. (16)

15. (a) The cylinder of a single- acting reciprocating pump is 15 cm in diameter and 30 cm in stroke. The pump is running at 30 r.p.m. and discharge water to a height of 12 m. The diameter and length of the delivery pipe are 10 cm and 30 m respectively. If a large air vessel is fitted in the delivery pipe at a distance of 2 m from the centre of the pump, find the pressure head in the cylinder.

(i) At the beginning of the delivery stroke, and

(ii) In the middle of the delivery stroke. Take $f = 0.01$. (16)

Or

(b) (i) Explain in detail the working principle and construction of rotary pumps with neat sketch. (8)

(ii) Calculate the work saved by fitting an air vessel for a double acting single cylinder reciprocating pump. (8)
